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Reply

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Walden et al. [this issue] make two main points: first, that inversion depth should be defined on the basis of mean monthly profiles and second, that changes in observing practices have introduced biases in the rawinsonde data which lead to erroneous conclusions about trends in inversion depths. We address both of these points.

As noted by *Bradley et al.* [1992], past studies have been inconsistent in the definition of lower tropospheric inversions in the Arctic. We explicitly defined surface-based inversions and showed that such conditions vary in frequency from <20% in summer months to >85% in midwinter at some sites. Computation of mean profiles, which are then used to identify "the top of the mean inversion," involves combining two populations of daily profiles which are fundamentally different (Figure 1). Surface-based inversions are associated with distinct synoptic conditions and are most apparent (and persistent) under clear-sky, anticyclonic situations. When pressure gradients are stronger, mixing of the boundary layer commonly destroys the surface-based inversion. Of course, there will be situations when minor changes in the temperature structure lead to the top of the principal inversion being identified prematurely. Whatever definition one chooses, there will be such problems, but these are not likely to significantly bias the mean depth over a 4-month average, which was the period used in our analysis of surface-based inversions [*Bradley et al.*, 1993]. We note that even using three other definitions of inversions (height of the warmest point in mean profiles, as suggested by *Walden et al.* [this issue], or mean height of the warmest point in individual profiles, or mean height of the warmest point only on days with surface-based inversions), a downward trend in inversion depth is still identified in observations at Point Barrow (Figure 2). The more important question is whether these trends are due to observational changes or to real changes in climate.

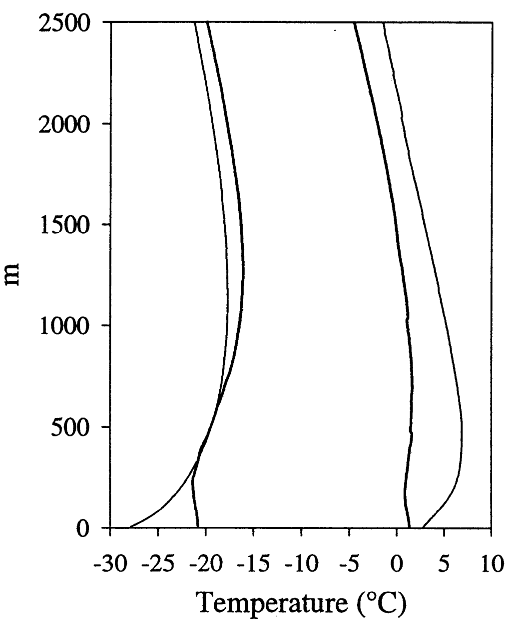

Figure 1. Mean temperature profiles of days with surface-based inversions (thin line) and all other days (thick line), for Point Barrow, Alaska. Profiles on the left are the mean for December to March and on the right for June to August.

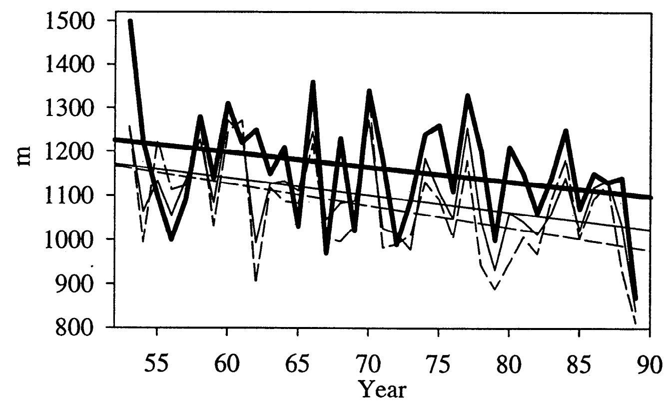

Figure 2. Mean inversion depth at Point Barrow Alaska (December-March) based on three definitions. Slope is based on simple linear regression. Thick line denotes height of warmest point in mean profile (all days) (slope of -3.4 m/yr); thin line denotes mean height of warmest point in individual soundings (all days) (slope of -3.9 m/yr); and dashed line denotes mean height of warmest point of inversions on days with surface-based inversions only (slope of -5.0 m/yr).

By careful examination of the changes in instrumentation and observational protocols at Point Barrow, *Walden et al.* [this issue] identify important problems which are likely to have introduced bias into the rawinsonde record. These issues are not well documented for Canadian stations. Although changes in balloon gas were not made at Canadian sites (unlike Barrow), it seems likely that these sites were also affected by many of the changes in instrument characteristics and observational practices documented by Walden et al. *Bradley et al.* [1993] noted that there has been a small increase in the number of significant levels recorded at most sites but were unable to ascribe this to instrumentation or to

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real changes in atmospheric structure. Walden et al.'s analysis makes the former explanation more likely, but whether this accounts for all or only part of the observed downward trend in inversion depth (Figure 2) is difficult to assess. It is unfortunate that changes in instrumentation and observational protocols are often introduced without a period of parallel observations to enable the effects of such changes to be quantified. As a result, important changes in inversion structure may be obscured by inconsistent observational practices.

References

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